

745 65

For your Information and Retention
Compliments of
Technical Information Section
(Library)

19960628 053

Volatile Corrosion Inhibitors

DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited



U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards

December 1964

DTIC QUALITY INSPECTED 1

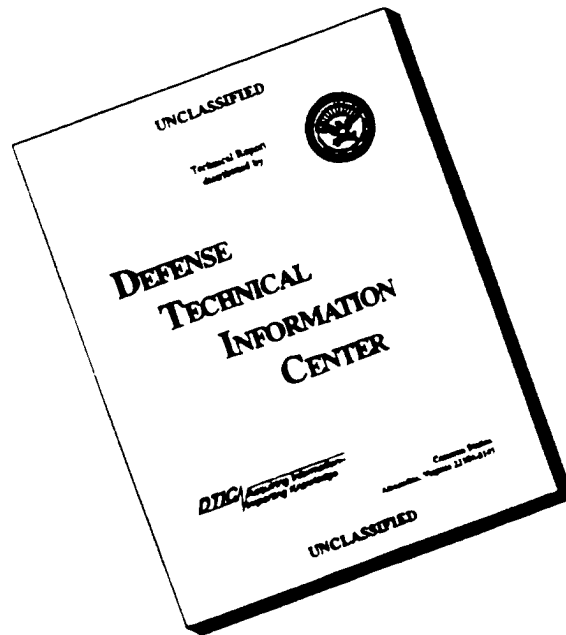
FOR SALE BY:

Clearinghouse for Federal Scientific and Technical Information
U.S. Department of Commerce, Springfield, Va., 22154
Price 50 cents.

DEPARTMENT OF DEFENSE
PLASTICS TECHNICAL EVALUATION CENTER
PICATINNY ARSENAL DOWD N. J.

DTIC 8/31

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

U. S. DEPARTMENT OF COMMERCE
Luther H. Hodges, Secretary

National Bureau of Standards
A. V. Astin, Director

Institute for Applied Technology
Donald A. Schon, Director

This study is one of a series of reviews of selected Government research and development reports. It highlights significant technical information for the attention of the industrial community. These reports may offer ideas for materials and product development and/or means of reducing production costs.

The Department of Commerce assumes no responsibility for the accuracy of statements or representations contained in the reports published in this review; nor does it make any warranty or representation, express or implied, as to the accuracy, completeness or usefulness of the information contained in this document. The Department of Commerce does not warrant that the use of any information, apparatus, method or process published in this document will not infringe privately-owned rights. References contained herein to commercial products or processes are not endorsements or recommendations.

CONTENTS

	PAGE
Abstract	3
Review of Research Reports	3
Introduction	3
Protection of Steel	4
Protection of Nonferrous Metals	5
Exterior Packaging Materials	6
Miscellaneous Guides	6
Recent Bibliography and Abstracts (1962-64)	9
Earlier Bibliography (1952-62)	11

VOLATILE CORROSION INHIBITORS

ABSTRACT

Significant reports covering the period since 1962 were selected for this study, with reference to relevant earlier works. Recent government R&D on volatile corrosion inhibitors (VCI) has generally proceeded along three lines: extension of tests defining the protective value of these materials for longer storage periods to steel equipment, tolerances of various nonferrous materials and finishes toward tarnishing or corrosion by these materials, and effectiveness of exterior packaging materials in extending use of these inhibitors to more severe exposures of water vapor and liquid. Volatile corrosion inhibitors in the form of salts, dissolved in oils, or coated on paper within enclosed shipment parcels or storage spaces offer improved corrosion protection to bare steel while it is in a ready condition for withdrawal and immediate use.

REVIEW OF RESEARCH REPORTS

Introduction

For the past several years government agencies have been keenly interested in better corrosion protection in storage and more rapid withdrawal of equipment in a condition ready for use. Continuing progress in the use of volatile corrosion inhibitors has resulted from studies by these agencies in three major areas: evaluation of time in which steel is fully protected under varying external conditions, effect of inhibitor materials upon nonferrous metals, and the effect of the outside package materials. These studies, which are available from the Clearinghouse for Federal Scientific and Technical Information, Department of Commerce, have potentially wide application in delivering products to the consumer in more ready-to-use condition.

Corrosion inhibitors are employed to prevent damage to the surface of metals during stages of packaging, storage, shipment and use of equipment. This damage results from the attack on the metal surface by moisture in liquid or vapor form and by the presence of acids or soluble salts.

Volatile corrosion inhibitors provide protection for simple to complicated metallic assemblies so that these packaged items can be used immediately without the tedious and costly procedures normally associated with the removal of preservatives containing oil or grease. Other methods of protection, such as storage in controlled low humidity warehouses or in completely impermeable packaging materials, are not usually required with properly used volatile corrosion inhibitors.

Volatile corrosion inhibitors are amine salts of weak inorganic acids and amine-organic acid complexes. Contained in trays or cloth bags, or coated on paper and placed within enclosed equipment or packages, they have the power of preventing the corrosion of stored steel.

These compounds act as vapor sources for the transfer of benzoate, nitrite, or other corrosion-inhibiting compound radicals to the surface of the metal to be protected. The amine part (or radical) of these compounds contributes to the low volatility, and in addition to providing corrosion-inhibiting action of its own, serves as an alkalizer or neutralizer of traces of acid vapors which might be present.

The selection of these compounds depends on the humidity, salinity, porosity of packaging, infiltration of outside atmosphere to which the packaged steel equipment may be exposed, as well as the vapor pressure of the compound at the temperature of shipment and storage. There is also some risk of tarnishment and corrosion of nonferrous metals such as zinc, magnesium, and cadmium and their alloys.

Commonly used compounds are dicyclohexylamine nitrite (DCHN), cyclohexylamine carbonate (CHC), and mixtures of sodium nitrite and urea. A qualitative comparison of the compounds and their use (PB-111 407P) lists the following ammonium or amine positive radicals: dicyclohexyl, cyclohexyl, amyl, isoamyl, diisopropyl, isopropyl, dibutyl, monethyl, diethyl, triethyl, and naphthyl. The following negative radicals are also used: nitrite, benzoate, butyrate, phosphonate, sulfonate, salicylate, carbonate, and carbamate. Some of these compounds are proprietary in nature.

A recent and comprehensive bibliographic guide (AD-600 643P) on the general subject "Vapor Phase Corrosion Inhibitors for Nonferrous and Ferrous Metals" was compiled in 1963 by the Prevention of Deterioration Center, National Academy of Sciences. This guide lists 153 references (1947-63) including patents, U. S. Government reports, and technical magazines. General surveys of the literature also include a comprehensive 1954 review, PB-111 407P, "Volatile Rust Inhibitors" by Hayward R. Baker of the Naval Research Laboratory.

Protection of Steel

The most significant contribution of volatile corrosion inhibitors has been their demonstrated utility in protecting bare steel equipment from corrosion over long periods during shipment and storage.

The Army Chemical Center sponsored a study (AD-259 458P) in this area. Utility of these inhibitors on bare steel using paper carriers, aluminum foil, Mylar, as well as crystalline or liquid salts was established for at least a 5-year period. Supplementary preservative oils and greases may be used with cast iron or phosphated surfaces. On complex assemblies, utility of these inhibitors has been demonstrated for preserving internal combustion engines, guns and small arms, containers and tankage. However, zinc, lead, silver, aluminum, cadmium, and copper may be tarnished or corroded by some or all the volatile corrosion inhibitors. Decorative or functional colored conversion coating applied to aluminum, copper and zinc may also be adversely affected by all volatile corrosion inhibitors.

Volatile organic compounds similar in type to vapor corrosion inhibitors can function as lubricants for high-speed ball bearing operations. The appli-

cation of VCI in small or individual containers is usually most practical. However, the protection in bulk or small item packaging is not effective without proper control of venting or leakage of the exterior packaging.

The Rock Island Arsenal, U.S. Army, has sponsored a study over 10 years, (PB-171 516P) evaluating the corrosion protection afforded by both volatile corrosion inhibitors and petrolatum type compounds on ferrous and non-ferrous ordnance materials. Volatile corrosion inhibitor papers were satisfactory for the preservation of gun and howitzer tubes and brought about a savings in time and labor because the tubes were ready for immediate use upon removal of the paper, with no degreasing operation required. Cadmium specimens were most severely attacked by the inhibitor that was composed of a combination of sodium nitrite and urea. Care should be exercised in the packaging of cadmium parts with volatile corrosion inhibitors; however, the other nonferrous metals tested exhibited only minor stain or tarnish.

The Army Ordnance Tank Automotive Command sponsored tests completed in 1962 (AD-282 328P) on installed engines as components of combat vehicles in outdoor storage. After at least three years of protection by volatile corrosion inhibitors—added either to the oil or blown into the cylinders in crystal form—only one of the eight test engines would not start. This failure was attributed to improper timing and not to corrosion. The oil treated with these inhibitors proved far superior to untreated oils after three years' storage.

Protection of Nonferrous Metals

The most adverse effect of volatile corrosion inhibitors is the effect of tarnish or even attack on many nonferrous metals. However, service experience is usually better on nonferrous components than indicated by laboratory tests.

A comprehensive bibliographic guide (AD-601 238P) on "Corrosion Inhibitors for Nonferrous Metals" was compiled in 1960 by the Prevention of Deterioration Center, National Academy of Sciences. This guide lists about five hundred references for the period 1947-1959 including patents, U.S. Government reports, and technical magazine articles. This guide, however, includes reports on many other types of corrosion inhibitors besides the volatile types.

The Rock Island Arsenal Laboratory has made a study (AD-427 151P) evaluating volatile corrosion inhibitors for a period of up to eight years in outdoor, shed, and indoor storage in order to determine the protection provided to packaged metal panels with various finishes. It was shown that these inhibitors provided no significant additional protection to nonferrous finishes such as cadmium and zinc plating beyond that given by regular Kraft paper packaging. Addition of a dip coating wax on the paper-wrapped metal panels and a well sealed outer packaging provided the best measure of protection. Chromium plated finishes required either exterior packaging or wax coatings on the volatile corrosion inhibitor paper in order to remain free of tarnish. For phosphated finishes the inhibitor papers provided no improvement over plain paper wrapping.

Severe corrosion of untreated zinc, cadmium, and magnesium may result from exposure to volatile corrosion inhibitors. Chromate or anodic treatments of these metals may prevent corrosion by some of the inhibitors.

Anodizing usually provides good resistance of aluminum to corrosion by the inhibitors. Blackened copper may show a dull, faded appearance when exposed to VCI.

With longer exposures, these inhibitors cause increased staining, softening, or peeling of the magnesium fluoride or zinc sulphide films on coated optical equipment. VCI does not inhibit fungi attack on stored equipment in humid atmospheres.

Exterior Packaging Materials

The protection to uncoated steel provided by a volatile corrosion inhibitor depends on the near absence of moisture and on the continuous condensation of the compound's vapor on the metal surface. If the VCI papers or oils are to be effective, the exterior packaging should be nearly impermeable to moisture or other weathering agents.

Using steel rifle components with a manganese phosphate finish as the materials to be protected, the Springfield Armory Laboratory (AD-295 474P) investigated the effectiveness of volatile corrosion inhibitors in both outdoor humid storage and polyester exterior packaging. A waterproof-vaporproof packaging composed of heat-sealable polyester material and volatile corrosion inhibitor provided satisfactory protection for twelve months in a humidity cabinet, and longer protection in an outdoor shed. Packages that were not vaporproof did not stand up as well in these tests.

The Rock Island Arsenal (AD-421 514P) studied the effect of indoor and outdoor storage upon the properties of exterior packaging materials used with volatile corrosion inhibitors. While there was no appreciable effect on tensile strength, tearing strength, and water resistance of packaging there was some increase in its vapor transmission and loss-of-seam strength after storage for five years. Some of the older polyvinylidene chloride and Kraft paper exterior packaging materials deteriorated at seals during outdoor storage for two years. However, material produced according to the more recent MIL-B-121 government specifications was found satisfactory for five-year test periods.

The Rock Island Arsenal (AD-425 370P) made another study of panels sealed in exterior transparent plastic films for one-year exposure. Bare steel panels sealed in these plastic bags were free of rust after one year of indoor heated storage. VCI inserts provided protection to bare steel panels when the plastic film packages were kept in a humidity cabinet at 100°F, and 95 to 100% relative humidity; however, when the VCI was lost through small openings or in reaction with the bag materials, rusting occurred. Polyethylene (0.004 inch) and polyvinyl chloride acetate copolymer (0.008 inch) bag materials provided the best external packaging for protecting bare steel panels in the humidity cabinet tests.

Present applications of volatile corrosion inhibitors either coated in paper or dissolved in oil offer excellent protection during shipment and storage of such steel equipment as gun tubes, containers, tanks, components of gasoline and diesel engines, and electronic equipment. These parts are ready for immediate use when the external packing is removed.

Miscellaneous Guides

Some of the volatile corrosion inhibitors are reported in the technical

magazine literature according to their proprietary names and corresponding industrial firms. Recent sources of information are:

"Protective Papers for Corrosion Control of Metals," by H. W. Mumm and W. S. Grimes. TAPPI, Vol. 45, No. 8, p. 129A-131A, August 1962.

Corrosion (Volume 2, Corrosion Control), by L. L. Shreir, 1963. Published by John Wiley & Sons, Inc., New York, N. Y.

RECENT BIBLIOGRAPHY AND ABSTRACTS
(1962-64)

Reports with prices preceded by CFSTI may be ordered from U.S. Department of Commerce, Clearinghouse for Federal Scientific and Technical Information, or from U. S. Department of Commerce Field Offices. Prices cited are for hard copy unless marked MF for microfiche. Order forms will be found in the back.

Reports with prices preceded by LC are to be ordered from Library of Congress, Photoduplication Services, Publication Board Project, Washington, D. C., 20540. Make check or money order payable to chief, Photoduplication Service, Library of Congress. State whether report is wanted in microfilm or photocopy.

AD-282 328P Ordnance Tank-Automotive Command, Detroit, Mich. ENGINE CORROSION STUDY ON INSTALLED ENGINES AS A COMPONENT OF A COMBAT VEHICLE IN OUTDOOR STORAGE AT ANNISTON ORDNANCE DEPOT, ANNISTON, ALABAMA, J. DeGroot, June 62, 36p., CFSTI \$5.60.

VCI oil proved far superior to the presently used MIL-L-21260 oil after a minimum of 3 years outdoor storage under actual conditions. Of 24 cylinders (2 test engines) using the VCI oil, 17 were corrosion free after 3 years. The other 7 cylinders developed spotty and not too severe corrosion during the 3rd year of storage. MIL-L-21260 oil displayed sufficient corrosion on 12 of 24 cylinders to question satisfactory operation of the engine after reassembly without considerable rework and/or salvage. Half of the cylinders showed corrosion in the first year. There was no apparent attack from the VCI oil or VCI crystals on nonferrous or nonmetallic components of the engine.

AD-295 474P Springfield Armory, Mass. INVESTIGATION OF PACKAGING METHODS AND SUBMETHODS WITH VOLATILE-CORROSION-INHIBITOR-TREATED MATERIALS, G. Pributsky, Aug. 62, 45p., CFSTI \$1.25.

Various submethods with volatile-corrosion-inhibitor-treated materials in the packaging of small arms components were investigated. Packages were stored under two conditions: (1) in an outdoor shed to simulate minimum warehouse storage and (2) in a static humidity cabinet to simulate tropic storage. Heat-sealable polyester film with volatile-corrosion-inhibitor innerwrap provided satisfactory protection in the humidity cabinet for one year. Results of this investigation indicate that packaging submethods other than those specified in MIL-I-8574 can be satisfactorily used with VCI preservatives. Test procedures are described and results given.

AD-421 514P Rock Island Arsenal Lab., Rock Island, Ill. NATURAL AGING OF BARRIER MATERIALS AT ROCK ISLAND ARSENAL, L. W. Lynch, July 63, 33p., CFSTI \$1.00.

The effect of natural aging on the properties of selected barrier materials conforming to Military Specification JAN-P-117, MIL-B-121 and MIL-B-131 has been determined. The materials tested have been in storage for intervals up to nine years at Rock Island Arsenal. The properties are compared with specification requirements and original properties. Certain properties of JAN-P-117, Type II and JAN-P-117, Type I, Class C were seriously deteriorated within two years. MIL-B-121 and MIL-B-131 materials were not appreciably affected by the storage. Physical properties and water resistance properties were generally not affected, material resistance to moisture vapor and grease were reduced and the seam construction was adversely affected by the longterm storage.

AD-425 370P Rock Island Arsenal Lab., Rock Island, Ill. PACKAGING IN TRANSPARENT BAGS, L. H. Wagner, Aug. 63, 44p., CFSTI \$1.25.

Eighteen transparent plastic films of various thicknesses were made into bags. Bare steel panels, panels overwrapped in vinylidene chloride copolymer, panels coated with an emulsifiable rust preventative and panels protected with VCI materials were sealed in the bags. These packs were then subjected to fresh water immersion, static and dynamic humidity, cyclic exposure and one year of indoor storage tests to determine the suitability of plastic bags for packaging applications. The extent, nature and intensity of the rusting of the test specimens were noted through the transparent bag materials.

The control packs, after one year of indoor exposure at ambient temperature, provided adequate protection without the use of VCI materials. It was also determined that the packs were unable to provide adequate protection to the control panels when immersed in fresh water and exposed to high humidity conditions. Cyclic exposure revealed that the emulsifiable rust preventative coating was unable to withstand exposure at high temperature. Incompatibility between polystyrene and the vinylidene chloride copolymer overwrap was noted at high temperature. A yellowish coloration was also noted on several plastic bags containing VCI materials.

AD-427 151P Rock Island Arsenal Lab., Rock Island, Ill. THE USE OF VOLATILE CORROSION INHIBITORS WITH FERROUS AND NON-FERROUS METAL FINISHES, R. E. Johnson, May 63, 47p., CFSTI \$1.25.

Four VCI materials were evaluated up to eight years in outdoor, shed, and indoor storage to determine the degree of protection provided to packaged ferrous and nonferrous metal panels with various finishes, and to determine the necessity of providing a well sealed package to reduce the loss of VCI vapors. One of the VCI materials was found to be superior to all other materials evaluated. It was shown that the VCI materials provided no significant protection to nonferrous finishes, such as cadmium and zinc plate. The addition of an overwrap of MIL-B-121, Grade C barrier material and a coating of VV-S-190 dipcoating wax to the VCI wrapped panels provided the greatest amount of protection to both ferrous and nonferrous finishes.

AD-600 643P Prevention of Deterioration Center, NAS-NRC, Washington, D. C. BIBLIOGRAPHY ON VAPOR PHASE CORROSION INHIBITORS FOR NONFERROUS AND FERROUS METALS, H. Janecka, Nov. 63, 22 p., CFSTI 75 cents.

Listing of 153 government reports, patents, and technical magazine references (1947-1963) on vapor phase inhibitors.

EARLIER BIBLIOGRAPHY
(1952-62)

PB-111 407P U. S. Naval Research Lab., Washington, D.C. VOLATILE RUST INHIBITORS, H. R. Baker, March 54, 21p., LC \$4.00, microfilm \$2.25.

PB-136 411P Frankford Arsenal Lab., Philadelphia, Pa. GASOLINE STORAGE TANK-VAPOR PHASE CORROSION INHIBITOR TEST, W. J. Shields and A. Gallaccio, Aug. 52, 17p., LC \$3.30, microfilm \$2.40.

PB-143 295P Container Labs., Washington, D. C. EVALUATION OF VOLATILE CORROSION INHIBITORS FOR PRESERVATION AND PACKAGING, PART I. LITERATURE SURVEY AND PRELIMINARY INVESTIGATION, G. S. Mustin, Jan. 58, 87p., LC \$13.80, microfilm \$4.80.

PB-143 440P Rock Island Arsenal Lab., Rock Island, Ill. CHARACTERISTICS OF VCI MATERIALS WHEN APPLIED AS PACKAGING MEDIA, F. H. Wayne, Feb. 59, 15p., LC \$3.30, microfilm \$2.40.

PB-144 387P Rock Island Arsenal Lab., Rock Island, Ill. GUIDE FOR PRACTICAL PRESERVATION WITH VCI, R. L. LeMar, July 59, 30p., LC \$4.80, microfilm \$2.70.

PB-146 838P Rock Island Arsenal Lab., Rock Island, Ill. AN EVALUATION OF VOLATILE CORROSION INHIBITED OILS FOR THE INTERNAL PRESERVATION OF MACHINE TOOLS IN UNCONTROLLED STORAGE, R. E. Johnson, Nov. 59, 24p., LC \$4.80, microfilm \$2.70.

PB-146 992P Springfield Armory, Mass. INTERACTION OF PLASTICS WITH VOLATILE CORROSION INHIBITORS, R. L. Keleher and A. Hitchins, April 57, 20p., LC \$3.30, microfilm \$2.40. *Califf*

PB-147 338P Rock Island Arsenal Lab., Rock Island, Ill. THE EFFECT OF VOLATILE CORROSION INHIBITORS ON MIL-B-131 BARRIER MATERIALS, E. S. Burke, Feb. 60, 21p., LC \$4.80, microfilm \$2.70.

PB-147 431P Rock Island Arsenal Lab., Rock Island, Ill. CHARACTERISTICS OF VCI MATERIALS WHEN APPLIED AS PACKAGING MEDIA, L. H. Wagner, April 60, 18p., LC \$3.30, microfilm \$2.40.

PB-149 525P Aeronautical Materials Lab., Naval Air Material Center, Johnsville, Pa. INVESTIGATION OF THE EFFECTS OF VOLATILE CORROSION INHIBITORS ON MIL-B-131C BARRIER MATERIALS, D. Minuti and I. H. Curtis, Jan. 60, 13p., LC \$3.30, microfilm \$2.40.

PB-151 010P Rock Island Arsenal Lab., Rock Island, Ill. INTER-ACTIONS BETWEEN FOUR VOLATILE CORROSION INHIBITORS, R. L. LeMar, Dec. 57, 43p., CFSTI \$1.25.

PB-151 122P Rock Island Arsenal Lab., Rock Island, Ill. VCI OILS: PROPERTIES AND PROPOSED QUALITY CONTROL TESTS, R. L. LeMar, June 58, 61p., CFSTI \$1.75.

PB-151 766P Rock Island Arsenal Lab., Rock Island, Ill. VCI BIBLIOGRAPHY AND ABSTRACTS, R. L. LeMar, Oct. 58, 117p., CFSTI \$2.50.

PB-154 612P Naval Civil Engineering Lab., Port Hueneme, Calif. USE OF VOLATILE CORROSION INHIBITORS FOR PRESERVING THE INTERIOR SURFACE OF STEEL PIPE, C. V. Brouillette, 1958, LC \$3.30, microfilm \$2.40.

PB-171 516P Rock Island Arsenal Lab., Rock Island, Ill. THE USE OF VOLATILE CORROSION INHIBITORS AS A PRESERVATIVE MEDIUM FOR LONG TERM STORAGE OF ORDNANCE MATERIAL. ADDENDUM VII. RESULTS AFTER TEN YEARS OF EXPOSURE, R. E. Johnson, Feb. 61, 49p., CFSTI \$1.25.

PB-181 174P Coating and Chemical Lab., Aberdeen Proving Ground, Aberdeen, Md. IMPROVED MULTIPURPOSE CORROSION INHIBITOR, C. B. Jordan, Jan. 62, 21p., CFSTI 75 cents.

AD-259 458P Container Labs., Washington, D. C. THE SELECTION AND USE OF VOLATILE CORROSION INHIBITORS FOR THE PRESERVATION OF CHEMICAL CORPS EQUIPMENT AND MATERIAL, J. B. Weaver, June 61, 11p., CFSTI \$1.60.

ORDER FORM

• SEND TO:

U. S. DEPARTMENT OF
COMMERCE,
Clearinghouse for Federal Scientific
and Technical Information
Springfield, Va. 22151

• Name _____

Address _____

City, State, Zip Code _____

• Charge to Superintendent of Documents
Account No. _____ \$ _____

• Check or money order enclosed.
\$ _____

Make payable to:
National Bureau of Standards—CFSTI

CUT ALONG THIS LINE

Items listed below may be ordered direct from the Clearinghouse. All other reports reviewed should be ordered from the source cited. Mark quantity wanted.

	Quan.	Totals	OTR NUMBERS (50 Cents Each)	Totals
PB-151 010P	_____	\$1.25	101 Hot Machining	_____
PB-151 122P	_____	\$1.75	102 Nickel Titanium	_____
PB-151 766P	_____	\$2.50	Alloys	_____
PB-171 516P	_____	\$1.25	103 Photochromism and	_____
PB-181 174P	_____	\$0.75	Phototropism	_____
AD-259 458P	_____	\$1.60	104 Fire-Extinguishing	_____
AD-282 328P	_____	\$5.60	Material	_____
AD-295 474P	_____	\$1.25	Technology	_____
AD-421 514P	_____	\$1.00	105 Flame-Retardant	_____
AD-425 370P	_____	\$1.25	Textiles	_____
AD-427 151P	_____	\$1.25	Humidity-Controlled	_____
AD-600 643P	_____	\$0.75	Warehousing	_____
AD-601 238P	_____	\$1.00	107 Concrete Tech- nology	_____
			108 Volatile Corrosion Inhibitors	_____
			Total amount of order \$	_____

U.S. DEPARTMENT OF COMMERCE FIELD OFFICES

The Department of Commerce maintains Field Offices to enable the business community to avail itself locally of Government facilities designed to promote commerce.

Working closely with various units in the Department and, when necessary, with other Government agencies, the Field Offices provide business services to manufacturers, wholesalers, retailers, trade publications, trade associations, advertising agencies, research groups, financial institutions, and exporters and importers.

Field Offices act as sales agents of the Clearinghouse for Federal Scientific and Technical Information and the Superintendent of Documents, and maintain an extensive business reference library containing periodicals, directories, publications and reports from official as well as private sources.

ALBUQUERQUE, N. MEX. , 87101, U.S. Courthouse. Phone: 247-0311.	DES MOINES, IA , 50309, 1216 Paramount Bldg., 509 Grand Avenue. Phone: 284-4222.	NEW YORK, N.Y. , 10001, 61st Fl., Empire State Bldg., 350 Fifth Ave. Phone: LOngacre 3-3377.
ANCHORAGE, ALASKA , 99501, Rm. 306, Laussac-Sogn Building. Phone: BR 2-9611.	DETROIT, MICH. , 48226, 445 Federal Bldg. Phone: 226-6088.	PHILADELPHIA, PA. , 19107, Jefferson Bldg., 1015 Chestnut St. Phone: WALnut 3-2400.
ATLANTA, GA. , 30303, 75 Forsyth St., N.W. Phone: 526-6000.	GREENSBORO, N. C. , 27402, Room 407, U.S. Post Office Bldg. Phone: 273-8234.	PHOENIX, ARIZ. , 85025, New Federal Bldg., 230 N. First Ave. Phone: 261-3285.
BALTIMORE, MD. , 21202, Rm. 305 U.S. Customhouse, Gay and Lombard Sts., Phone: Plaza 2-8460 Ext. 2784.	HARTFORD, CONN. , 06103, 18 Asylum St. Phone: 244-3530.	PITTSBURGH, PA. , 15219, Room 2201 Federal Bldg., 1000 Liberty Ave. Phone: 644-2850.
BIRMINGHAM, ALA. , 35203, Title Bldg., 2030 Third Ave., North. Phone: 325-3131.	HONOLULU, HAWAII , 96813, 202 International Savings Bldg., 1022 Bethel St. Phone: 58931.	PORTLAND, OREG. , 97204, 217 Old U.S. Courthouse, 520 S. W. Morrison St. Phone: 226-3361.
BOSTON, MASS. , 02110, Room 230, 80 Federal St. Phone: CApiitol 3-2312.	HOUSTON, TEX. , 77002, 5102 Federal Bldg., 515 Rusk Ave. Phone: CA 8-0611.	RENO, NEV. , 89502, 1479 Wells Ave. Phone: FA 2-7133.
BUFFALO, N.Y. , 14203, 504 Federal Bldg., 117 Ellicott St. Phone: TL 3-4216.	JACKSONVILLE, FLA. , 32202, 512 Greenleaf Bldg., 204 Laura St. Phone: ELgin 4-7111.	RICHMOND, VA. , 23240, 2105 Federal Bldg., 400 North 8th St. Phone: 649-3611.
CHARLESTON, S. C. , 29401, No. 4 North Atlantic Wharf. Phone: 722-6551.	KANSAS CITY, MO. , 64106, Room 2011, 911 Walnut St. Phone: BAItimore 1-7000.	ST. LOUIS, MO. , 63103, 2511 Federal Bldg., 1520 Market St. Phone: MAIn 2-4243.
CHARLESTON, W. VA. , 25301, 3002 New Federal Office Bldg., 500 Quarrier St. Phone: 343-6196.	LOS ANGELES, CALIF. , 90015, Room 450, Western Pacific Bldg., 1031 S. Broadway. Phone: 688-2830.	SALT LAKE CITY, UTAH , 84111, 3235 Federal Bldg., 125 So. State St. Phone: 524-5116.
CHEYENNE, WYO. , 82001, 207 Majestic Bldg., 16th & Capitol Ave. Phone: 634-2731.	MEMPHIS, TENN. , 38103, 345 Federal Office Bldg., 167 N. Main St. Phone: 534-3214.	SAN FRANCISCO, CALIF. , 94102, Room 9453, Federal Building, 450 Golden Gate Ave. Phone: 556-5868.
CHICAGO, ILL. , 60604, 1486 New Federal Bldg., 219 S. Dearborn St., Ph. 828-4400.	MIAMI, FLA. , 33130, Rm. 1628, Federal Office Bldg., 51 S.W. 1st Ave. Phone: 350-5267.	SANTURCE, PUERTO RICO , 00907, Room 628, 605 Condado Ave. Phone: 723-4640.
CINCINNATI, OHIO , 45202, 8028 Federal Office Bldg., 550 Main St. Phone: 381-2200.	MILWAUKEE, WIS. , 53203, Straus Bldg., 238 W. Wisconsin Ave. Phone: BR 2-8600.	SAVANNAH, GA. , 31402, 235 U.S. Courthouse and Post Office Bldg., 125-29 Bull St. Phone: ADams 2-4755.
CLEVELAND, OHIO , 44101, 4th Floor, Federal Reserve Bank Bldg., East 6th St. & Superior Ave. Phone: 241-7900.	MINNEAPOLIS, MINN. , 55401, Room 304, Federal Bldg., 110 S. Fourth St. Phone: 334-2133.	SEATTLE, WASH. , 98104, 809 Federal Office Bldg., 909 First Ave. Phone: MUtual 2-3300.
DALLAS, TEX. , 75202, Room 1200, 1114 Commerce St. Phone: RiVerside 9-3287.	NEW ORLEANS, LA. , 70130, 909 Federal Office Bldg., (South) 610 South St. Phone: 527-6546.	
DENVER, COLO. , 80202, 142 New Custom House, 19th & Stout St. Phone: 297-3246.		

U.S. DEPARTMENT OF COMMERCE
CLEARINGHOUSE FOR FEDERAL
SCIENTIFIC AND TECHNICAL INFORMATION
SPRINGFIELD, VA. 22151

POSTAGE AND FEES PAID
U. S. DEPARTMENT OF COMMERCE

OFFICIAL BUSINESS

A CLEARINGHOUSE FOR TECHNICAL INFORMATION

The Clearinghouse for Federal Scientific and Technical Information (formerly Office of Technical Services) collects, announces and distributes to the public unclassified technical information from the Department of Defense, Atomic Energy Commission, National Aeronautics and Space Administration and other Federal sources. Translated foreign technical reports also are available.

Abstracts of new reports are published twice a month in *U.S. Government Research Reports* (\$15 a year domestic). Foreign technical material is announced semimonthly in *Technical Translations* (\$12 a year domestic). They may be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

Science abstracts of the Communist countries appear in the following journals available on subscription from the Clearinghouse: *USSR Science Abstracts*, *East European Scientific Abstracts*, *Communist Chinese Scientific Abstracts*, and *Soviet-Bloc Research on Geophysics, Astronomy and Space*.

Mailed free on request from the Clearinghouse are the following: *Special Announcements*, flyers listing new reports in many fields of interest to industry such as plastics, welding and electronics, and *Selective Bibliographies*, listing more than 300 collected reports of high industrial interest.

A Technical Literature Searching Service, using the combined facilities of the Clearinghouse, Science and Technology Division of the Library of Congress, and the Science Collections of the Departments of Interior and Agriculture can be "tailormade" to the users requirements at a fee of \$11 an hour (8 hours minimum searching time).

Inquiries on reports and services are to be directed to Clearinghouse, U.S. Department of Commerce, Springfield, Va. 22151 or to any Commerce field office (listed on inside back cover).